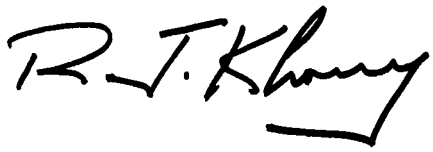
VIRGINIA DEPARTMENT OF TRANSPORTATION

TRAFFIC ENGINEERING DIVISION

MEMORANDUM

GENERAL SUBJECT: BARRIER SYSTEMS	**NUMBER:** TE-366.0
	TO SUPERSEDE: N/A
SPECIFIC SUBJECT: **GUARDRAIL SYSTEM UPGRADE** Functional Condition Ratings and Upgrading Strategies of Existing Guardrail Systems	**DATE:** January 27, 2012
	SUNSET DATE: None
DIRECTED TO: District Administrators Regional Operations Directors District Maintenance Engineers State Maintenance Engineers State Location and Design Engineer Regional Operation Maintenance Manager Regional Traffic Engineers Residency Administrators	**SIGNATURE: State Traffic Engineer** 

Guardrail systems are an important roadside safety feature. To ensure they perform their intended functions, periodic review of in-service guardrail systems for timely upgrade and repair are necessary.

The enclosed "Virginia Department of Transportation Guardrail System Upgrade Guidance" provides guidance to determine the functional condition ratings and upgrade strategies of existing guardrail systems. The term "guardrail systems" refers to typical guardrail sections such as W-Beam and cable barriers, transition areas, and guardrail end treatments. The functional condition ratings are designed to measure the functionality of guardrail systems compared with the current FHWA/VDOT standards. The ratings are to be used to determine the level of upgrade and recommended improvement timelines to guide investment decisions. This memo is to be used in conjunction with TE Memo-367, which provides condition ratings and repair strategies for damaged guardrail systems and end treatments as part of the "Hits Repair" program.

CC: Mr. Greg Whirley
Ms. Constance S. Sorrell
Mr. Malcolm T. Kerley, P.E.
Ms. Irene Rico
Division Administrators

Enclosure: Virginia Department of Transportation Guardrail System Upgrade Guidance

Virginia Department of Transportation
Guardrail System Upgrade Guidance

Central Office
Traffic Engineering Division
January 27, 2012

1. POLICY BACKGROUND

Guardrail systems are roadside safety features for redirecting errant vehicles from a dangerous path. The term "guardrail systems" here refers to typical guardrail sections such as W-Beam and cable barriers, transition areas and guardrail end treatments. Because guardrail systems are potential hazards themselves, they shall only be used when it is necessary to shield vehicles from a more hazardous condition. If the hazard is no longer present or no longer deemed a hazard at the site, the installation should be scheduled for removal.

To ensure that existing guardrail systems are still warranted and that they are capable of performing their intended function, periodic review and evaluation of in-service guardrail systems are necessary. This memorandum provides guidance to determine the functional condition ratings and upgrade strategies of existing guardrail systems. The functional condition ratings of guardrail systems, which are similar to a bridge condition rating, shall be used to determine the severity of the problem, level of upgrade and timelines to assist in prioritizing investment decisions.

Related Policy Guidance

This memo shall be used in conjunction with **TE Memo-367** when addressing damaged guardrail issues. TE Memo-367 provides guidance on determining damage condition ratings and spot-repair strategies for damaged guardrail systems and end treatments as part of the "Hits Repair" program. Refer to Maintenance Division guidance on cost-recovery options.

Refer to the latest **IIM-LD 220** for guidance and guidelines on the upgrading existing guardrail systems associated with construction and major rehabilitation projects, Refer to **VDOT Guardrail Installation Training (GRIT)** Manual for general information on the installation, replacement and repair of guardrail systems. All new guardrail installations shall comply with current VDOT standards and specifications.

A system methodology to periodically collect physical inventory information and functional condition information will be established under a separate guidance.

2. EVALUATING FUNCTIONAL CONDITIONS OF GUARDRAIL SYSTEMS

2.1 Field Inspection Scope

Field inspection **should** be conducted to evaluate the functional conditions of guardrail systems. The inspection shall be performed by VDOT GRIT-certified personnel. At a minimum, the inspector shall:

- Evaluate the appropriateness of the installed guardrail and identify potential needs for new guardrail at the specified location
- Examine guardrail for damage and any signs of rust and deterioration

- Assess guardrail for compliance with current AASHTO/VDOT standards and specifications
- Check guardrail height for compliance with current VDOT standards
- Check guardrail systems for compliance with current VDOT/NCHRP 350 standards and verify cable tension where applicable
- Determine if the Length of Need (LON) is in accordance with GRIT manual
- Check all hardware for tightness and proper size
- Check all offset blocks for proper position
- Check if there is any fixed object within the deflection area
- Check the shoulder and area beneath the guardrail for excessive erosion
- Check the shoulder width behind the posts to ensure proper support of the posts
- Check guardrail location relative to any curb
- Where applicable, check if the weak post and strong post systems are properly transitioned
- Check all timber posts for damage, rot or insect infestation
- Check steel posts for rust, being bent or badly deflected
- Identify other obvious defects of guardrail and end treatments to be fixed.

The inspector can be directed to conduct additional work as required by VDOT engineers.

2.2 Functional Condition Ratings

General Criteria

The following provides general criteria to be used in determining the functional condition ratings of existing guardrail systems.

Grade A– Guardrail system is evaluated to be fully functional and capable of providing protection as intended. Guardrail system meets current VDOT standards, specifications, policy and/or current FHWA testing criteria based on field observations and measurements of rail heights.

Grade B – Guardrail system is evaluated to be adequately functional under a majority of impacts but may not meet all current VDOT standards. Guardrail system will be rated as Grade B if all of the following features, as applicable, are discovered:

- Guardrail height is:
  - W-beam Strong Post Systems(GR-2, GR-10, GR-FOA): 27"-30"
  - W-beam Weak Post Systems (GR-8): 31"-34"
  - Cable Weak Post Systems (GR-3): 26"-29"
- End terminals meet current NCHRP 350 standards,
- May have steel blockouts with backup plates present,
- Does not have washers at Rail bolts.

Grade C– Guardrail system is evaluated to provide some protection for errant vehicles but does not comply with VDOT's current standards. Guardrail system will

be rated as Grade C if any of the following features are discovered:

- Guardrail height is:
  - W-beam Strong Post Systems(GR-2, GR-10, GR-FOA): Minimum 24"-27", Maximum 30"-33"
  - W-beam Weak Post Systems (GR-8): Minimum 29"-31", Maximum 34"-36"
  - Cable Weak Post Systems (GR-3): Minimum 24"-26", Maximum 29"-31"
- End terminals do not meet current NCHRP 350 standards,
- The Guardrail system has steel blockouts with no backup plates present
- The run-on end section has less than 1' of cover at anchorage.

Grade D- Guardrail system is evaluated to provide little protection for the errant vehicles. Guardrail system will be rated as Grade D if any of the following features are discovered:

- Guardrail height is:
  - W-beam Strong Post Systems(GR-2, GR-10, GR-FOA): Less than 24", Greater than 33"
  - W-beam Weak Post Systems (GR-8): Less than 31", Greater than 34"
  - Cable Weak Post Systems (GR-3): Less than 24", Greater than 31"
  - Proprietary High Tension Cable Systems: Does not meet manufacturers' requirements
- Has steel blockouts present and with washers installed on the rail bolts,
- Blunt End Terminals for W-beam guardrail or median barrier,
- Turned-down terminals,
- Bridge approach guardrail that is not connected to the bridge railing,
- Has less than one foot of soil backing behind posts,
- Fixed object is within deflection area of guardrail system.

Weathering Steel (COR-TEN or ASTM A588) W-Beam Guardrail

Weathering steel guardrail and end treatments are no longer acceptable for use due to the potential for premature material failure from excessive rust. All weathering steel guardrails and end treatments shall be rated as, at a minimum, Grade C or D based on the above criteria. Upgrade options are provided in Section 4: GUIDANCE ON GUARDRAIL SYSTEMS UPGRADE AND TIMELINES of this memo.

Detailed Criteria for Specific Guardrails

For detailed rating criteria for each guardrail type, **refer to the Condition Rating Table/Matrix in Appendix A.**

3. GUIDANCE ON GUARDRAIL SYSTEMS INSPECTION

The detailed guidance on guardrail system inspection is provided in the VDOT Guardrail Installation Training (GRIT) Manual and the VDOT Road and Bridge Standards and Specifications. The following provides key elements of the guidance related to guardrail system inspection.

3.1 Guardrail Sections

Measuring the Height of Guardrail Section

The height of the cable or w-beam rail elements is critical for the proper performance of the guardrail system. The cable or w-beam rail elements must contact the design vehicle bumper at the correct position to prevent vaulting over or running under the guardrail system. One important point to consider in determining the proper height of the system is the technique or method used to measure the height of the cable/rail elements. The location of the guardrail system relative to the slope beneath the cable/w-beam element will determine how the height of the guardrail is measured. Guidelines as defined for the standard guardrail systems listed below shall be used when measuring the height of respective guardrail systems. The ground profile grade for these systems must be on a 6:1 or flatter slope.

- For Standard GR-2 the minimum height to the top of the rail is 27¾" and the maximum height is 28¾". The height is measured at the posts with a splice in linear increments of 50 feet.

- For Standard. GR-8, the installed height is 31½"-33" (32¼" ±¾") to the top of the rail. The height is measured at the posts or posts at a splice, as appropriate, in linear increments of 50 feet.

- No W-beam system should be placed between 2' and 12' from the shoulder hinge point on a slope steeper than 10:1.

- For GR-3 cable systems, the height is 27"–28" to the top cable. The height of the cable system is measured at the posts in linear increments of 48 feet.

- For transitions between systems measure the height at the posts at the beginning and end of the transition between standard systems.

- For proprietary systems follow the manufacturer's instructions to determine height.

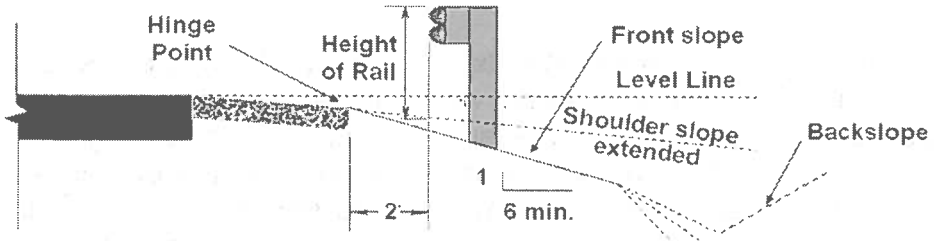
- If the face of the W-beam is above a 10:1 or flatter surface, measure the height from the ground directly below the face of the w-beam.

- Where grading is steeper than 10:1, but not steeper than 6:1, and the w-beam is within 2' of the shoulder/front slope hinge point (see below) for Standard GR-2 and GR-8, the height is measured from the shoulder slope extended.

- If the w-beam rail is 12' or more from the shoulder/front slope hinge point, measure guardrail height from the ground directly below the face of the rail.

- For GR-3 cable systems installed on 6:1 or flatter surface; the height shall be measured directly from the ground directly below the cable.

Please refer to the following illustration for a graphical description of the guardrail height measuring procedure for W-Beam systems.



Hinge point : the point where the roadside cross section changes from one cross-slope to another, such as from the shoulder cross-slope to the front slope.

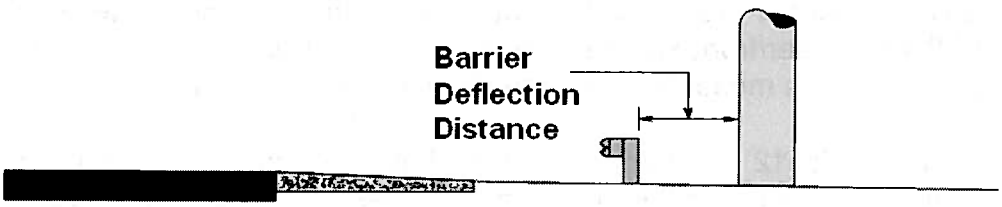
Soil Backing

The area immediately behind the guardrail systems' post directly affects the performance of the system. Therefore the distance behind the guardrail shall be measured to assess the condition of the system. On a 6:1 or flatter slope, a minimum distance of one (1) foot from the back of guardrail post is required.

Guardrail Deflection Distance

Guardrail systems are designed to absorb energy during a vehicle impact. This is accomplished by the guardrail's ability to deflect upon impact. Dynamic deflection distance shall be measured from the back of guardrail posts. No rigid or semi-rigid object (hazard) shall exist within the deflection distance of any guardrail system as shown in the Table below.

Guardrail System	Maximum Deflection Distance (ft)
GR-2	3
GR-2A	2
GR-3	11
GR-8	7
GR-8A	5
GR-8B	4



3.2 Guardrail End Treatments

Site preparation for all installations shall be in accordance with current Standards. The following items shall be inspected when assessing the condition of an existing guardrail end treatment installation.

- GR-3 Anchorage – Height of top cable, length of terminal, location and type of first post a compared to current standard, length of terminal.

- GR-6 – Height of rail, number of rail elements, system transition prior to the ditch, slope of rail element, depth the end anchorage, or adequacy of back slope. Note: anchorage should be buried at least 1' deep and should not be exposed.

- GR-7 – Manufacturer/Model, height of rail elements, breakaway posts, extruder assembly, reflective sheeting, and cable anchorage, if applicable

- GR-9 – Manufacturer/Model, height of rail elements, breakaway posts, extruder assembly, reflective sheeting, and cable anchorage, if applicable

Existing end treatments should be checked to ensure the run of guardrail is adequate to shield the vehicle from the hazard that exists. The following process should be used to determine adequate length of need in the field.

- GR-3, GR-7 and GR-9 Terminals – Refer to the GRIT Manual - Chapter 1 or the AASHTO Roadside Design Guide.

- GR-6 Terminals – 75 feet minimum from where the rail element crosses the cut/fill break or flow line of the ditch to the hazard

4. GUIDANCE ON GUARDRAIL UPGRADE STRATEGIES AND TIMELINES

4.1 Upgrade Strategies

Due to funding limits, only guardrail systems with functional condition ratings of Grade C or D are recommended for upgrade. The general upgrading strategies for the following substandard guardrail systems are as follows. Users should use engineering judgment to provide the best upgrade strategies for a specific situation.

- **Standard GR-1**

  All Standard GR-1 guardrails should be identified and replacement schedules set for all roadway systems so that appropriate funding can be budgeted for upgrades. Standard GR-1 on any roadway within the National Highway System (NHS) shall receive first priority for upgrading as soon as possible.

- **Standard GR-5**

  All Standard GR-5 turn-down terminals installed at "run-on" locations on the National Highway System shall be removed and replaced immediately with the appropriate terminal treatment meeting NCHRP 350 criteria.

  Damaged GR-5 terminals on roadways shall be replaced with an appropriate terminal treatment meeting NCHRP 350 criteria. All other GR-5 terminals on non-NHS roadways shall be scheduled for upgrading per scheduling guidelines.

- **Standard GR-6**

  Site investigation shall be conducted to determine whether a cut slope is within approximately 200' longitudinal distance from the location of an existing GR-7 or GR-9 terminal. If warranted, the guardrail shall be extended to the cut slope and a Standard GR-6 installed.

  If the installation site does not provide at least 75' of clear run-out path in addition to the length of need required for the barrier (exclusive of the terminal), a GR-9 terminal should be installed.

- **Standard GR-7**

  A site investigation shall be made to determine whether the terminal should be upgraded or eliminated.

  If the space between two runs of guardrail is $\leq$ 200', closing the gap by continuing the run of guardrail is recommended, thereby eliminating the need for a terminal. If an extensive amount of grading would be required for site preparation to install a Standard GR-7, consideration should be given to installing a Standard GR-9.

- **Standard GR-8**

  For any existing GR-8 guardrail adjacent to curb, the curb shall be removed. For existing CG-3 (4" curb) or CG-7 (4" curb and gutter) that cannot be removed, refer to the current GR-INS Standard. For existing CG-2 (6" curb) or CG-6 (6" curb and gutter) that cannot be removed, refer to the instructions in IIM-220.

- **Standard GR-9**

  A site investigation shall be made to determine whether the GR-9 terminal should be upgraded or eliminated. If the space between two runs of guardrail is $\leq$ 200', closing the gap by continuing the run of guardrail is recommended, thereby eliminating the need for a terminal.

- **Standard GR-11 and Additional Longitudinal Guardrail as End Anchorage**

  Rectangular washes used on the trailing end section (last 50 feet) of any longitudinal GR-2 guardrail on divided highways should be replaced with GR-11.

- **Weathering Steel (COR-TEN or ASTM A588) W-Beam Guardrail**

  Unless otherwise noted, weathering steel guardrail systems shall be upgraded to galvanized steel guardrail according to the appropriate VDOT standards.

  In rare situation, when roadside barriers are required in areas where aesthetics is a primary concern, VDOT may utilize powder coated galvanized steel guardrail. This includes W-beam, posts, terminals, fixed object attachments, and all hardware. **The use of power coated galvanized steel guardrail shall be limited and must be approved by the Regional Traffic Engineer.** The installed guardrail system should be earth-tone in color. A Special Provision Copied Notes on Powder Coated Galvanized Guardrail Special Provision can be obtained from the Materials or Scheduling and Contract Divisions.

  There are two exceptions that allow the use of weathering steel:

  - Weathering steel may be used on the backside of the Steel Backed Timber rails and for the posts and hardware used with them, as the steel thickness is significantly greater than the typical 12 gage W-beam section. The Steel Backed Timber Guardrail is a special design and additional information is available from the Standards/Special Design Section of the Location and Design Division.
  - Weathering steel system (w-beam, posts, and hardware) may be used if requested by an agency outside of VDOT. However, the agency must agree, through a Memorandum of Agreement, to maintain the installation by implementing a rigorous inspection and replacement schedule as referenced in the FHWA memorandum-Roadside Design: Steel Strong Post W-beam Guardrail issued on May 17, 2010.

- **Radial Guardrails**

  All radial guardrails at driveways and private entrances shall be replaced with either GR 9 or GR-11 as appropriate or per standards.

4.2 Upgrade Timelines

Only guardrail system with a functional condition ratings of C or D are recommended to be upgraded. The recommended timelines for guardrail upgrade is still under development. Unless otherwise noted, currently there is no specific requirement for the system upgrade timelines.

For guardrail upgrade in paving projects, refer to the VDOT Safety Assessment Guideline for Paving Project for required timeline.

Appendix A:

Functional Condition Rating Table/Matrix

This table only applies to evaluating existing guardrail systems based on existing pavement elevations. If assessment is part of a pavement overlay, then the overlay thickness and resulting guardrail height must be taken into consideration during the assessment of the guardrail system's functional condition rating.

Standard Guardrail Designation	Description	Functional Condition Rating Grade			
		A	B	C	D
GR-1	• Post Spacing: 12'-6" • Post Size: 6" steel, 8" wood/concrete • Blockouts: No				X
GR-2 or GR-2A	• Post Spacing: 6'-3" or 3'-1½" • Post Size: 8" • Blockouts: 8" Wood or Composite • Back-up plates: Yes, at non-splice locations • Rail Height: 27¾"-28¾"	X			
	• Post Spacing: 6'-3" or 3'-1½" • Post Size: 8" • Blockouts: 6" Steel Blockouts • Back-up plates: Yes, at non-splice locations • Washers Present: No • Rail Height: 27¾"-28¾"		X		
	• Post Spacing: 6'-3" or 3'-1½" • Post Size: 8" • Blockouts: Wood, Composite or Steel • Rail Height: Less than 27¾" or Greater than 28 ¾"			X	
	• Post Spacing: 6'-3" or 3'-1½" • Post Size: 8" • Blockouts: 6" Steel Blockouts • Back-up plates: Yes, at non-splice locations • Washers Present: Yes • Rail Height: Less than 27¾"-28¾" or Greater than 28 ¾"			X	
	• Post Spacing: 6'-3" or 3'-1½" • Post Size: 8" • Blockouts: 6" Steel Blockouts • Back-up plates: No, at non-splice locations • Washers Present: Yes • Rail Height: 27¾"-28¾"				X

Standard Guardrail Designation	Description	Functional Condition Rating Grade			
		A	B	C	D
GR-3	• Post Spacing: 16 ft • Post Size: 3" • Cable Height: 27"-28" • Terminal: NCHRP 350 compliant	X			
	• Post Spacing: 16 ft • Post Size: 3" • Cable Height: 27"-28" • Terminal: Non-NCHRP 350 compliant			X	
	• Post Spacing: 16 ft • Post Size: 3" • Cable Height: Less than 27" • Terminal: Non-NCRPH 350 compliant			X	
	• Post Spacing: 16 ft • Post Size: 3" • Cable Height: Greater than 28" • Terminal: Non-NCHRP 350 compliant			X	
	• Non-NCHRP 350 Terminal run on condition				X
GR-4 or GR-4A	• 37'-6" Length of GR-2A as a Fixed Object Attachment (FOA) • Run-off Condition on Divided Roadway	X			
	• 37'-6" Length of GR-2A as a Fixed Object Attachment (FOA) • Run-on Condition			X	
GR-5	• GR-2 Turn-down Terminal • Run-off Condition on Divided Roadway	X			
	• GR-2 Turn-down Terminal • Run-on Condition				X
GR-6	• Rail height of 27¾"-28¾" relative to roadway and maintained to anchorage • Rail element(s) buried 1' in Backslope • Foreslope 4:1 or flatter • Backslope 4:1 or steeper	X			
	• Rail height of 27¾"-28¾", Rail height not held constant relative to roadway and/or maintained to anchorage • Rail element(s) not buried 1' in Backslope • Foreslope 4:1 or flatter • Backslope 4:1 or steeper		X		
	• Rail height less than 27¾" or greater than 28 ¾" • Rail height relative to the roadway not maintained to ditch bottom • Rail element(s) exposed at anchorage • Foreslope steeper than 4:1 • Backslope flatter than 4:1			X	
GR-7	• Proprietary terminal meeting NCHRP-350 test criteria (Stamped on 1st post) • Rail height of 27¾"-28¾" • Meets site preparation standards	X			
	• Proprietary terminal meeting NCHRP-350 test criteria (Stamped on 1st post) • Rail height less than 27¾" or greater than 28¾" • Does not meet site preparation standards			X	

Standard Guardrail Designation	Description	Functional Condition Rating Grade			
		A	B	C	D
GR-7	• **MELT:** Non-Proprietary terminal meeting NCHRP-230 test criteria (strut between first two wooden breakaway posts, cable anchorage) • Rail height of 27¾ "-28¾" • Meets site preparation standards		X		
	• **BCT:** Non-Proprietary terminal not meeting any test criteria (concrete footings for first two posts, large posts, no metal strut, posts not breakaway, cable anchorage) • Rail height of 27¾"-28¾"				X
GR-8 or GR-8A or GR-8B	• Post Spacing: 12'-6", 6'-3" or 3'-1½" • Post Size: 3" • Rail splice between posts (GR-8 only) • Back-up Plates: Yes, at non-splice locations • Rail Height: 31½"-33"	X			
	• Post Spacing: 12'-6", 6'-3" or 3'-1½" • Post Size: 3" • Rail splice at posts (GR-8 only) • Back-up Plates: Yes, at non-splice locations • Rail Height: 30"-31"		X		
	• Post Spacing: 12'-6", 6'-3" or 3'-1½" • Post Size: 3" • Rail splice at posts (GR-8 only) • Back-up Plates: Yes, at non-splice locations • Rail Height: less than 30"			X	
	• GR-8 turn down terminal • Run-on condition				X
GR-9	• Proprietary terminal meeting NCHRP-350 test criteria (Stamped on 1st post) • Rail Height: 27¾"-28¾" • Meets site preparation standards	X			
	• Proprietary terminal meeting NCHRP-350 test criteria (Stamped on 1st post) • Rail Height: Less than 27¾" or Greater than 28¾" • Does not meet site preparation standards			X	
GR-10 Type 1	• Rail Height: 27¾"-28¾" • Span: 12'-6" • 25' double nested w-beam	X			
GR-10 Type 2	• Rail Height: 27¾"-28¾" • Span: 18'-9" • 37'-6" double nested w-beam	X			
GR-10 Type 3	• Rail Height: 27¾"-28¾" • Span 25' maximum • 100' double nested w-beam • 6" X 8" CRT posts with two 8" blockouts	X			
GR-10 Type 1	• Rail Height: Less than 27¾" or greater than 28 ¾" • Span: 12'-6" • 25' double nested w-beam		X		
GR-10 Type 2	• Rail Height: Less than 27¾" or greater than 28 ¾" • Span: 18'-9" • 37'-6" double nested w-beam		X		

Standard Guardrail Designation	Description	Functional Condition Rating Grade			
		A	B	C	D
GR-10 Type 3	• Rail Height: Less than 27¾" or greater than 28 ¾" • Span: 25' maximum • 100' double nested w-beam • 6" X 8" CRT posts with two 8" blockouts		X		
GR-11	• Non-crashworthy terminal end treatment for anchorage • Run-off condition only	X			
	• Run-on condition				X
Blunt End	• Guardrail terminated with blunt end				X
GR-FOA-1 or GR-FOA2	• Nested W-Beam with "C" shape rub-rail • 8" X 8" wood or W8 X 13 steel posts adjacent to fixed object	X			
	• Nested W-Beam with "C" shape rub-rail • 6" X 8" wood or W6 X 8.5 steel posts adjacent to fixed object		X		
	• Nested W-Beam with W-Beam rub-rail • 6" X 8" wood or W6 X 8.5 steel posts			X	
GR-FOA-3	• Nested W-Beam with No rub-rail • 6" X 8" wood or W6 X 8.5 steel posts • Fixed object tapers away from traffic and terminates behind FOA		X		
GR-FOA-4	• Nested W-Beam with W-Beam rub-rail • 6" X 8" wood or W6 X 8.5 steel posts (Median Application)	X			
GR-FOA-2 or GR-FOA-4	• Nested W-Beam with W-Beam rub-rail • 6" X 8" wood or W6 X 8.5 steel posts • Missing steel spacer tube			X	
Longitudinal Guardrail as Anchorage	• Additional 50 feet of guardrail beyond length of need with washers • Run-off condition			X	
Aesthetic Guardrail	• Cor-Ten Steel W-Beam Rail, Posts, and Hardware.			X	
Soil Backing	• Less than 1 foot of soil behind the posts due to erosion.				X
Guardrail Deflection	• All fixed objects are outside of the deflection area of the guardrail system	X			
	• A fixed object is within the deflection area of the guardrail system				X